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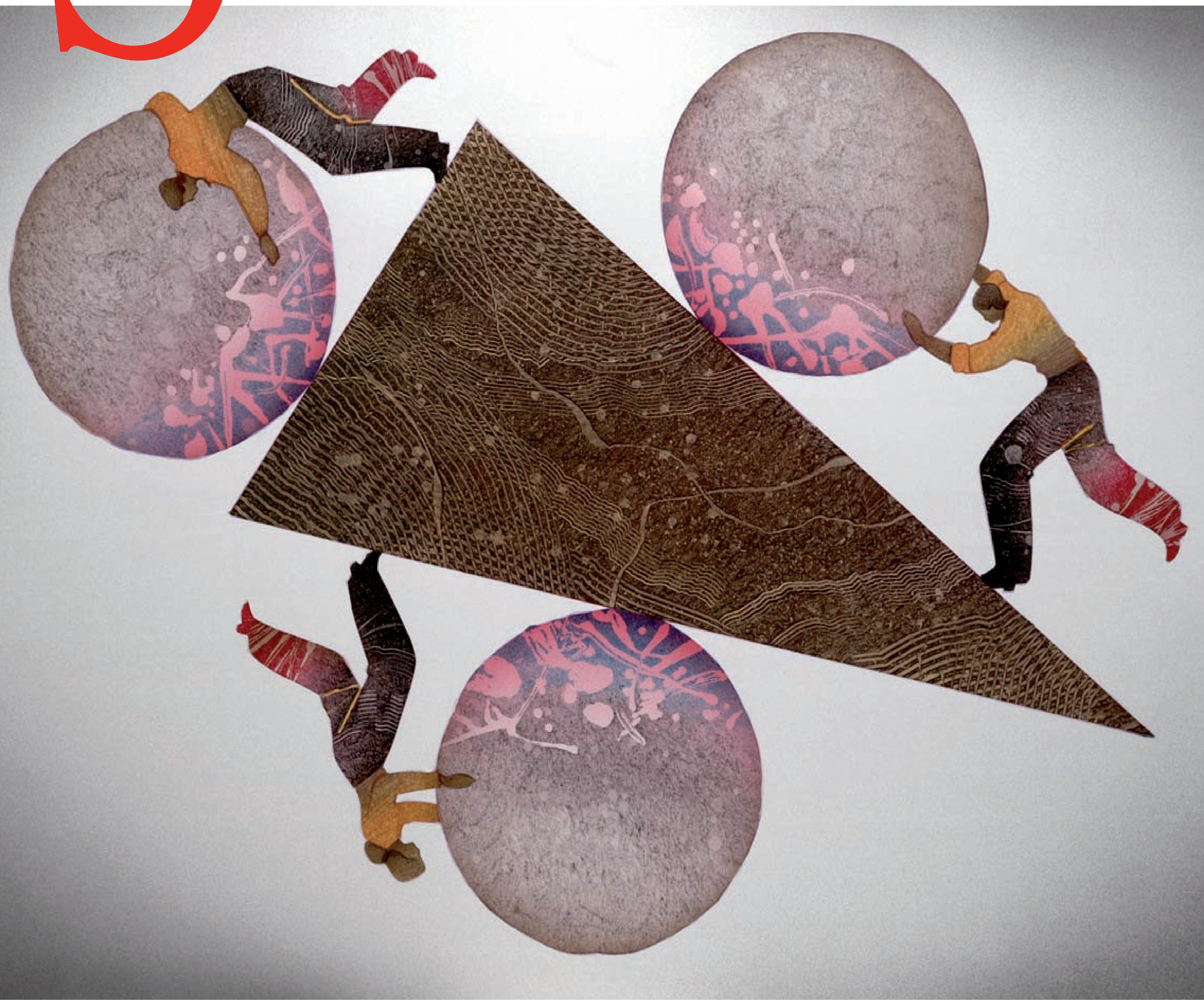

The Nitrogen Cycle: The N*in*E European Project

- Explosive atmospheres control
- Risk of violence at work: The KAURIS Method
- PSE-ARFRISOL, an energy-saving alternative
- Sustainable mobility

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Criteria for fire and explosion prevention and protection on industrial sites

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On 1 July 2003 Real Decreto 681 / 2003 became enforceable and binding on all new industrial establishments with a risk of explosive atmospheres. As from 30 June 2006 it also became enforceable for all industrial establishments with a risk of explosive atmospheres. As a result of this new legislation all these establishments are now bound to draw up an explosion protection document.

Without getting too bogged down in legal niceties, which have been dealt with in many articles elsewhere, we do need first and foremost to understand the phenomenon of «combustion».

Once we understand the general principle of fire, combustion, conflagration, explosion, etc... we then have to see whether and how far this might affect our activity; it is well worthwhile here to pause a moment and put on our safety glasses (by which we mean not donning safety goggles but seeing things from the safety viewpoint) and check whether we are actually in a risk situation.

Despite not having had any accident for years, the ingredients might still be there, biding their time. We can look for guidelines in the accidents that have occurred in our sector, as telltale signs of whether or not we are handling «hazardous» substances.

For example, an analysis of the dust explosion figures in the American grain sector over the last four decades of the twentieth century shows that this risk is not negligible: 15 explosions per year, 6 deaths per year and 25 injuries per year, plus the economic losses, which are not mentioned in this report. (Figure 1).

Figure 1. Total 1958 to 1998

Number of explosions	616
Number of deaths	243
Number of injuries	1.018

After several accidents the American authorities decided to regulate the sector. The OSHA Grain Handling Facilities Final Rule was duly published on December 31, 1987 with an effective date of March 30 1988, greatly helping thereafter to cut down the accident rate. (Figure 2).

This same effect is expected from the European ATEX Directive 92/99, which has been implemented into Spanish law as Real Decreto 681/2003.

This successful example will doubtless be convincing proof that regulation works and is necessary. On this assumption we will now analyse the phenomenon of fire, since any improvement depends on a proper understanding of the risk involved.

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Where is there an ATEX?

The first thing we need to establish is whether the substances involved are flammable and, if so, where their sensitivity limits lie and how severe the explosion would be. It is essential to find out the risk involved. If these substances are flammable, therefore, the next step we need to take in an industrial site is to localise the explosive atmospheres (colloquially shortened to ATEX) and prevent them from igniting or, if the ignition does in fact occur, control the generation of released energy.

Neither should we forget that the ATEX generation may be temporary or accidental; here is where the ATEX zoning classification comes in; this classification needs to be thorough but without overdoing it. For example, an industrial building ten metres high should not be classified as ATEX zone 22 on the grounds that there is or might be flammable dust on the floor, for the direct consequence of this is that its lighting and electricity system would have to be category 3D, meaning that it could be repaired in the future only by an authorised installer. Such overzealous zoning would hence lead to an unnecessary and avoidable surcharge for the user concerned.

After identifying the ATEX risk we need to take the ignition prevention measures to suit this explosive atmosphere. The typical measure is to remove the ignition sources by bringing the site's equipment into line with the identified ATEX zone and establishing safe working methods.

The first measure to be taken by the entrepreneur is the training and awareness raising of his/her workers, since this single measure will slash the hazardousness drastically. If not already in place, a work permit system should be set up, with special stress on heat work (cutting and welding).

The next step is to find out all the ignition source prevention techniques and ascertain which are applicable to our particular process. For example, if we wish to prevent sparks of a mechanical origin, a very efficient measure might be a turning-speed limit, or a magnet in a mill inlet might prevent the entrance of nails, etc.

Thus, to control the ignition sources we need to see where we have permanent explosive atmospheres and establish whether they are a hazard to people if the explosion actually occurs.

In sum, we should:

- **Ascertain the explosiveness of the substance** or substances. If there are several, we will take the most hazardous as reference.
- **Identify risk-prone equipment**, prioritising prevention and protection in light of the probability of failure and coexistence with an ATEX.
- **Evaluate economically** the cost of the measures taken (investment set against the safety improvement).
- **In view of all the above, DEFINE THE PRIORITIES**.

Following these 4 steps will enable us to set up an explosion prevention and protection criterion on our site. ◆

Figure 2. Annual means

	1958 to 1987	1988 to 1998
Number of explosions	15.7	13.2
Number of deaths	7.3	2.3
Number of injuries	29.1	13.2

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KAURIS method for assessment and management of risk of violence at work

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Introduction

In the 1990s, violence was recognized as an emerging problem in working life. In addition to Finland, attention was paid to violence at work also in the other member states of the European Union, in the U.S.A. and in many other countries. In Finland, research projects were launched in order to produce information on the problem and to provide tools for prevention. A KAURIS method for assessment and management of risk of violence at work was developed in connection with a research project carried out in 1997-2000 and a guidebook was published for workplaces.

KAURIS method

The KAURIS method was developed under the guidance of the author in connection with a research project carried out at the Finnish Institute of Occupational Health. The Finnish Work Environment Fund supported the project. The KAURIS method is based on a model for the assessment and management of the risk of violence at work developed in the project. The KAURIS guidebook was published in 2001 to help workplaces in the assessment and management of workplace violence. During the development process, the KAURIS material was tested in practice, and it was also reviewed by the collaboration partners representing the authorities, employers' and employees' organizations and other groups.

A participative approach is utilized in the implementation of the KAURIS method. A team (consisting of foreman and workers) is formed for each workplace. In addition, other personnel are involved in the improvement process. The first task of the team is to make a risk assessment by utilizing a questionnaire and a check-list provided for the purpose. The questionnaire is delivered either to the whole personnel or only to e.g. those persons working in a customer service (Isotalus & Saarela 2001, Saarela 2001).


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The team makes a summary of the present situation at the workplace on the basis of the questionnaire survey, the assessment of the preparedness of the workplace made by utilizing the checklist, and other relevant material. The team continues by planning measures for improving safety by utilizing the information sheets included in the KAURIS method describing technical measures, organizational measures, procedures, guidelines and training, reporting and analysis of the incidents and post-incident support for the victims. The training of the personnel is recommended always to be included as one measure in the improvement process. The team takes care that the measures are also implemented in practice. The effectiveness of the health and safety management system of the workplace in preventing violent situations has to be monitored and improvements made if needed (Isotalus & Saarela 2001, Saarela 2001). ◆

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Nitrogen in Europe: Activities addressing the European Nitrogen Cycle

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European ecosystems are under threat from many pressures, including changes in landuse, atmospheric composition and climate. These anthropogenic disturbances lead to major changes in water and nutrient cycles. Globally, one of the most perturbed nutrient cycles is the atmospheric nitrogen cycle. Intensified agriculture and combustion of fossil fuels increase the amounts of reactive nitrogen, and these compounds will, when released to the environment, have a cascade of effects to human health and ecosystems. Agricultural activities release ammonia (NH_3), nitrous oxide (N_2O) and nitric oxide (NO) to the atmosphere, while nitrate (NO_3^-) and ammonium (NH_4^+) are released to aquatic systems. Fossil fuel combustion from stationary and mobile sources is well known to emit nitrogen monoxide (NO) and nitrogen dioxide (NO_2) (collectively termed NO_x). Equipment installed in order to reduce emissions of nitrogen oxides e.g. catalytic converters in cars cause emissions of small but significant amounts of NH_3 and N_2O.

The main drivers of change in the European nitrogen budget are the anthropogenic fixation of nitrogen by agriculture, leading to releases of NH_3, N_2O, NO and NO_3^-, the import of nutrients from other parts in the world through concentrates, food, and high temperature combustion processes, which oxidize a fraction of the atmospheric N_2 to NO_x. The presence of excess N in these reactive forms leads to an extremely wide range of environmental problems:

- elevated ground level ozone concentration with impacts on crops, natural vegetation and human health impacts (NO and NO_2);
- aerosol formation with impacts on light scattering, reduction of visibility, coronary and respiratory diseases and direct negative effect on the global radiative balance. Furthermore an often indirect global cooling effect is possible (e.g. ammonium nitrate –NH_4NO_3– and ammonium sulphates –e.g., NH_4HSO_4, $(NH_4)_2SO_4$);
- eutrophication of nutrient-poor aquatic and terrestrial ecosystems decreasing biodiversity (deposition of oxidized-N - NO_y - and reduced-N - NH_x);
- soil acidification, with consequent changes in species composition and water quality (deposition of NO_y and NH_x);
- potential human health risks from drinking-water and changes in aquatic ecosystems (enhanced NO_3- concentrations in ground and surface waters);
- euthrophication of marine areas, leading to increased risks of algae blooms and hypoxia (excess N-flow and atmospheric deposition);
- global warming and stratospheric ozone depletion (N_2O);
- effect on the CO_2 and CH_4 fluxes between ecosystems and the atmosphere in a positive (sink) and negative (source) way (additional N supply from atmospheric deposition).

Once released into the environment nitrogen compounds may contribute to a cascade of the above-mentioned effects before getting into a final sink as N_2 molecules or immobilized in soils or sediments. The nitrogen cascade may be illustrated by the fate of nitrogen excreted by livestock: a significant fraction is emitted as NH_3, with additional losses as N_2O, NO and NO_3-. Subsequent atmospheric deposition of the NH_3 leads to further N_2O and NO emissions and NO_3- leaching. The atmosphere provides a means to disperse the N widely, resulting in perturbation of the nitrogen cycle in areas remote from direct human intervention.

Figura 1. The N*in*E Logo.

The N*in*E logo reflects the challenge to interlink 9 major environmental problems. The 9 problems being addressed are:

- Aquatic Eutrophication
- Coastal & Marine Eutrophication
- Terrestrial Eutrophication & Biodiversity
- Acidification of soils & waters
- Stratospheric chemistry & ozone
- Greenhouse gas & global warming
- Ozone - vegetation & health
- Urban air quality & health
- Particles - health, visibility & global dimming

The logo places N*in*E at the centre of the transdisciplinary network, and also provides a mnemonic for the 9 problems: «ACT AS GROUP». This emphasizes the need to join our efforts in delivering a fully integrated assessment of European nitrogen problems and their future solutions.

The nitrogen cascade can be illustrated by the fate of nitrogen excreted by livestock

It requires a broad interdisciplinary approach and the development of strategies to optimize the need for a key human resource like nitrogen, while minimizing its negative consequences. A program trying to address this interdisciplinary approach is Nitrogen in Europe (or in short N*in*E). N*in*E addresses the issues that will be relevant for solutions for the future, while looking at the European nitrogen cycle as a whole and aims to integrate European research and researchers, eventually delivering an assessment report of the state of European nitrogen knowledge, sources, transformations and impacts, as well as establishing a basis to recommend future solutions.

As the major outcome of N*in*E, the European Nitrogen Assessment (ENA in short) will address current nitrogen issues, the cascade effects and the interactions and feedbacks. The ENA provides valuable insight for governments and other stakeholders in the balance between the benefits of fixed nitrogen to society, against the different adverse effects of excess nitrogen in the environment. Much is already known about nitrogen and its transformations in the environment. However, the complexity and extent of the interactions mean that current scientific understanding and policy making has become separated into several parallel streams.

Further European activities addressing nitrogen in an integrated way are COST Action 729, NitroEurope and the Task Force on Integrated Nitrogen. These programs try to involve science and policy in an attempt to make linkages between possible nitrogen issues. Although there is still a long way to go to understand 'nitrogen' to its full extend, the first activities in the context of N*in*E, NEU, COST Action 729 and TFRN are very promising. Bringing together scientists and policy makers from different fields and have them discuss a common problem is challenging. At the same time it is extremely rewarding, especially when a better mutual understanding of the different problems arises from these discussions. ◆

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PSE-ARFRISOL, an energy-saving alternative in office buildings

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In 2005 the Spanish Ministry of Science and Innovation (Ministerio de Ciencia e Innovación, MICINN), formerly the Ministry of Education and Science (Ministerio de Educación y Ciencia), decided to look into this matter in some depth by analysing actual, quantified cases in real usage conditions, the first endeavour of its kind in Spain. It did so through the National R&D Plan (Plan Nacional de I+D) setting up a special project called Singular and Strategic Project on Bioclimatic Architecture and Solar Cooling, shortened to PSE-ARFRISOL from its Spanish initials (Proyecto Singular y Estratégico sobre Arquitectura Bioclimática y Frío Solar). The aim of this project, coordinated by CIEMAT (National Research Centre for Energy, Environment and Technology), is to reduce energy consumption in five office buildings standing in areas of very different climatic conditions (two in Almería and one each in Madrid, Asturias and Soria). The idea is to experiment in the tertiary sector (offices of 1000 m^2) in the interests of then transferring energy-saving breakthroughs to the residential sector. The goal of the study is for each prototype, called «research-demonstrator collector» (contenedor-demostrador de investigación: C-DdI) to obtain an 80 to 90% saving on conventional energy by means of thermal conditioning, using a judicious mix of bioclimatic architecture and solar power for heating and cooling.

Research methodology, a step forwards on the strength of the CTE

The new legislation on the use of solar power for the thermal conditioning of buildings refers only to the production of domestic hot water (DHW) and we now need to use it also for heating and cooling purposes to do full justice to the CTE's (Technical Building Code) real spirit.

The end in view now is to harness the climate, orientation and design of each particular construction to reduce energy consumption, doing so by using thermal solar collectors and absorption machines to make further progress in the study of «solar cooling», i.e., harnessing the thermal application of solar energy, with the further backup of photovoltaic modules. Both the active and passive systems will be integrated into the all-embracing C-DdI project.

The researchers of PSE-ARFRISOL, in their quest for a detailed knowledge of constructions of this type, use theoretical models (simulation) and experimental models (monitoring) for gauging, assessing and quantifying each energy input or loss.

Simulation involves using mathematical models that include descriptions of the heat- and mass-exchange processes inherent in any building (conduction, convection, radiation, infiltrations, etc). On the basis of data on climate, architectural design, passive strategies and internal energy loads (lighting, occupation, electrical appliances and air conditioning equipment, etc.), simulation enables us to predict a building's energy behaviour (interior temperatures, heating demands, relative humidity, etc.). The only trouble is that each of these factors needs to be checked several times to gain a theoretical knowledge of a building's future behaviour, and this could be a long-winded and laborious process.

Given the mathematical complexity of these tasks, various specialist software systems have been developed and are now being used for analysing building energy use: ESP-R, DOE-2, SERI-RES, TRNSYS, ENERGYPLUS, ... etc, depending on the needs of each case. This software, however, calls for the development of mathematical algorithms and thoroughgoing research into the different design strategies, which are more complex and complete than the LIDER and CALENER models recommended by the CTE.

The monitoring process involves weighing up energy use on the basis of values recorded in real experience. These records include outside meteorological variables (solar radiation, ambient temperature, humidity, wind speed and direction) and also interior variables to ascertain energy behaviour and the thermal comfort obtained (temperature and humidity). This process begins immediately after constructing the building to measure real use conditions. In PSE-ARFRISOL this process is scheduled to last from 2008, the year in which construction work is expected to end, to 2010.

Conclusions

In short, the members of the PSE-ARFRISOL consortium aim to fulfil five different objectives involving the following:

- Five singular office buildings (research collectors-demonstrators) in terms of design, facilities and energy results quantified in real use conditions.
- Energy-efficient office buildings with energy saving of between 80% and 90%, measured, analysed and quantified, as compared with current buildings.
- Solar facilities and equipment: collectors, photovoltaic modules and absorption heat pumps, studied and optimised for rational energy use and marketing.
- Educational modules drawn up by appropriate teaching experts and put through their paces by «sampling» in chosen educational centres.
- Documents drawn up to «change the mindset» of different sectors of society with the aim of convincing end users to use heating and cooling systems, among other functions, to save energy both in summer and winter in any type of buildings, not only offices. ◆

Acknowledgements

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Sustainable mobility: Monitoring Population Mobility Patterns

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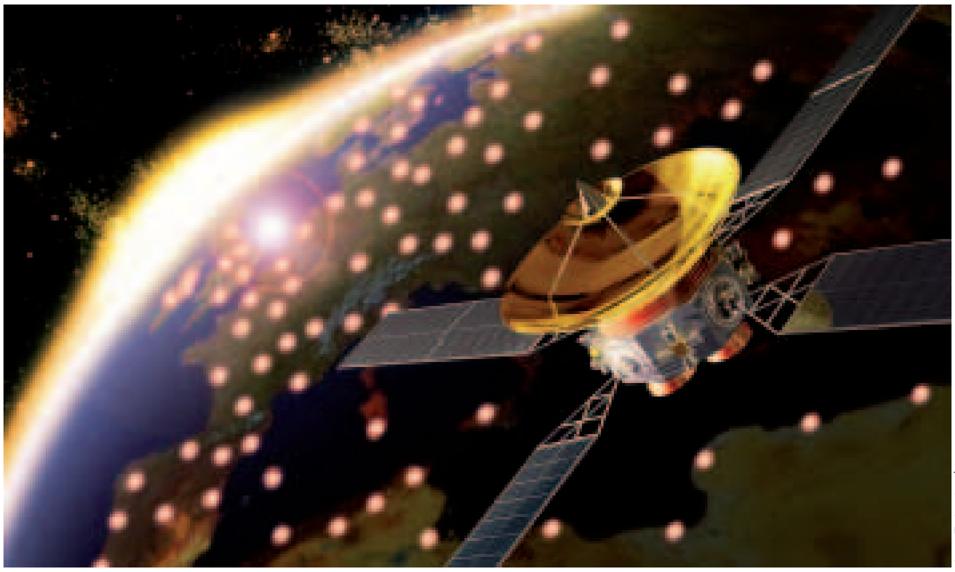
Population mobility might be a crucial factor in transferring various pathogens to other areas and infecting new human populations. Where the aetiology of the disease and the transmission vectors are well known, the study of the mobility of affected populations enables disease transmission models to be determined, helping to draw up strategies for its control. Knowledge of population mobility patterns might thus furnish information on ultimate recipients, allowing us to draw up control and healthcare-education strategies. Many transmittable diseases are avoidable, providing that the pertinent information is gleaned for controlling them and the necessary measures are taken quickly. The study of these patterns also helps us to understand the interaction between populations with different disease-prevalence and epidemic-outbreak indices, the evolution of which depends largely on inequality in medical attention. From Katrina to Darfur, from flu to AIDS, there is a crucial need of broadening concepts, examining trends and pinpointing intervention areas, in the interests of education, research, practice, protocols and rules and standards to follow for proper prevention of healthcare problems.

Citizens are now using mobile electronic devices with increasing frequency. These devices are becoming smaller and are even now being incorporated into articles of everyday use, including garments. They are thus becoming a ubiquitous technological resource that can be tapped into in various ways. One of these emerging applications consists of the incorporation of sensors in the mobile devices for ascertaining, for example, how people move about over a long period of time. As well as the tracking possibilities of these sensors, they could also be used for supervising environmental effects (e.g., traffic pollution) in a much more detailed way than has been possible hitherto.



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Wireless sensor networks have now come into their own as a technology to be applied with different objectives, in diverse places and moments. Although the sensor nodes of a wireless network still suffer from limitations in terms of energy and IT-resources, this technology still looks set to be an important source of information in the coming years. Georeferencing, as a link between (individual) mobile sensors, also has an important role to play here; together with the idea of a network structure composed of different nodes, it underpins the Shannon-Weaver model, often held up as a communication transmission benchmark. This model works from the sound assumption that more information means less uncertainty. This definition is bound up with the common idea of information acquisition, where the link between probability (entropy) and information is crucial for efficient coding and decoding within the communication transmission model.

The best-known tracking devices are the personal recording devices, which record the positions in which the device has been. They can then be plugged into a computer and their information uploaded to record the route the device has traced. GPS tracking in real time is also possible through a digital cellular network or by satellite. Examples of such devices might be a watch, a small GPS tracking device, a medical supervision unit or a mobile phone.

It is also possible to permanently track any vehicle by fitting it with a GPS receiver and transmitter module for sending data. A current example is the SPOT satellite messenger, consisting of a device that receives the GPS tracking data and sends them back to the satellite. The SPOT device has an alert «911» button, which, if pressed, notifies the International Emergency Response Center GEOS every five minutes until switched off. GEOS in turn contacts the local emergency provider, such as the Coastguard Service or a police department, giving the exact location of the device.

In this context, the Mercator Research Group (Grupo de Investigación Mercator) of the Universidad Politécnica de Madrid, run by professors Mónica Wachowicz and Miguel Ángel Bernabé, of the Higher Technical School of Topography, Geodesy and Cartography Engineers (Escuela Técnica Superior de Ingenieros en Topografía, Geodesia y Cartografía), participates in the development of theories, techniques and automated systems for creating a Mobility Information Infrastructure («Infraestructura de Conocimientos sobre Movilidad»), which supplies tools for the management and analysis of population mobility and fielding enquiries thereon. This infrastructure, the overall aim of which is to establish behaviour patterns of the people in the surrounding environment, consists of a repository for storing positioning data from thousands of tracking devices. Researchers can then access this pool of information for analysis purposes.

The goal of this data storage is the implementation of a multidimensional positioning data model adapted to online analytical processing (OLAP), facilitating the classical operations of information-analysis and -retrieval in the space-time dimensions. Examples of these operations are the retrieval of specific data on the basis of drill-down information or, conversely, the generation of roll-up information from specific data. Information of great interest on population mobility can thus be gleaned by means of statistical operations, such as the number of journeys of a given set of people, the average distance covered by them or the average, minimum and maximum speeds of these journeys.

The Mercator Research Group participates in the development of theories, techniques and automated systems for creating a Mobility Information Infrastructure

The techniques used for analysing the data stored in the repository include the development of space-time models and geovisualization. These techniques are capable of analysing huge amounts of data, generating useful and timely information on population mobility.

Fields of application

Several types of mobile applications have been developed to meet many of society's needs in relation to economic development, social and cultural experience, such as the applications created from location based services (LBSs). Existing LBSs can, for example, provide tourists with applications for finding out their location, finding addresses and routes, retrieving information on the environment they currently find themselves in or leaving comments in an interactive map [1]. A travel diary could also be compiled on the basis of the location of a tourist in a given time. Some systems are also capable of telling users about interesting spots to visit or displaying enriched information in an environment of enhanced reality. There are also LBS applications for transport, trade and process management.

The research results may be applied in studies of the environment to understand the movement patterns of dynamic entities, ranging from hurricanes and tornadoes to animals [2] and planes [3]. Specialised sensors could be designed to provide information on the movement of an entity and the environment it is located in, including information on light levels, pollution, proximity, noise, etc., enabling a dynamic perspective to be built up of the environment and the interactions between its components.

Other fields of application include surveillance through the use of sensors fitted with diverse resources (e.g., photography, video, GPS trackers, etc.) for security operations. MITRE Corporation recently described a project in which it developed a strategy for vehicle identification and monitoring by security officers, with the aim of pinpointing what it calls «precursors» of dangerous situations in the air. ◆

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